

BIOINFORMATIC STUDY OF THE EFFECT OF CORN HAIR (ZEA MAYS) ON THE REDUCTION OF CHOLESTEROL LEVELS IN THE BLOOD

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ABSTRACT

Corn hair (*Zea mays* L.) is an extension of the stigma of the female flower of the maize plant. So far, the use of corn hair, which is a waste from corn cultivation, is limited as a medicine for urinating and lowering blood pressure. The chemical composition of corn hair has the potential to be used to reduce cholesterol levels in the blood because of the presence of beta-sitosterol in it. Based on research it is known that giving corn hair decoction (*Zea mays*) has a very significant effect on reducing levels of total cholesterol, triglycerides and LDL cholesterol and increasing levels of HDL cholesterol. High levels of HDL cholesterol in the blood (about 40 mg/dl or more) are good for health. Conversely, a high LDL level (100 mg/dl or more) is a bad sign. The buildup of LDL on the walls of blood vessels can cause hardening of the walls of blood vessels which can cause hardening of the walls of the arteries (atherosclerosis) and block blood flow which can be fatal because it triggers disease, coronary heart disease and stroke.

Keywords: Beta-sitosterol; Cholesterol; Corn hair (*Zea mays*)

1. INTRODUCTION

Corn (*Zea mays* L.) is one of the world's most important food crops besides wheat and rice. Corn as the main source of carbohydrates in Central and South America, corn is also an alternative food source in the United States [1]. Residents of several regions in Indonesia (eg in Madura and Nusa Tenggara) also use corn as a staple food [2]. Apart from being a source of carbohydrates, corn is also grown as animal feed (forage and cobs), oil is taken (from the ears), made flour (from the ears, known as corn flour or cornstarch), and industrial raw materials (from grain flour and cob flour).). Corn cobs are rich in pentose, which is used as a raw material for making furfural. Genetically engineered corn is also now grown as a producer of pharmaceutical ingredients [3] [4].

The corn plant has many uses. Almost all parts of the corn plant from roots to leaves can be utilized. The part of corn that is widely used by the community is the fruit. They often ignore the waste from corn silk. Corn hair in everyday life is seen as a waste of the food industry and households, corn silk contains substances that are useful for health. Corn silk is the female flower of corn which is arranged in a cob in the leaf axils. Each cob has a stalk with short segments with leaves that are the dressing and the cob. The pistils are arranged in several rows on the cob earlier. Currently,

corn silk has not been used optimally by the community. One of the ingredients in corn silk that can be used to lower cholesterol levels in the blood is beta-sitosterol, because beta-sitosterol is a hypocholesterolemic [5].

The mechanism of action of beta-sitosterol in lowering blood cholesterol is firstly, reducing the absorption of cholesterol including triglycerides and other dietary fats in the digestive system. The reduction of cholesterol absorption is done by locking or binding fat molecules from food and blocking these fat molecules from being absorbed by intestinal mucosal cells [6].

The inhibition of absorption of cholesterol and triglycerides will cause chylomicron anabolism to be small which causes the serum triglyceride level to be small and the intake of dietary cholesterol and triglycerides to the liver is also reduced.. This will result in VLDL anabolism and low serum LDL cholesterol levels. The low VLDL anabolism causes low serum triglyceride levels. Cholesterol, triglycerides, and other dietary fats that are not absorbed by the intestinal mucosal cells due to the presence of beta sitosterol will be excreted in the feces along with bile salts. Beta-sitosterol is a plant sterol compound that is difficult to be absorbed by intestinal mucosal cells.

Beta-sitosterol that is not absorbed by the intestinal mucosal cells will also be excreted in the feces. Second, reduce the amount of cholesterol production in the liver. Beta-sitosterol has a ring structure identical to that of cholesterol, but differs in the bonding of the attached ethyl group.

2. LITERATURE REVIEW

2.1 Cholesterol

Cholesterol is a substance in the body that is useful for helping the formation of cell walls, bile salts, hormones, and vitamin D as well as producing energy. The main source comes from the liver (about 70%) and the rest comes from food that enters the body. Cholesterol in normal levels has a positive impact on the body [7]. However, if it has passed the normal limit, it will have a negative impact on health, especially in the long term. A recent survey in 8 Asian countries reported that 50% of Asians failed to lower their bad cholesterol levels according to the targets recommended in the treatment guidelines. In Indonesia, this failure even reaches 70% [8]. A very large number. Not surprisingly, diseases such as coronary heart disease and stroke are still one of the biggest factors causing death in Indonesia. In the United States, Heart disease is the leading cause of death, accounting for about 37% of deaths. About 88% of this number is caused by coronary heart disease [9].

Cholesterol in the body is mainly obtained from synthesis in the liver. The raw materials are obtained from carbohydrates, proteins, or fats. The amount synthesized depends on the needs of the body and the amount obtained from food. Cholesterol can only be found in foods of animal origin. The main sources of cholesterol are the liver, kidneys, and egg yolks. After that the meat, whole milk, and cheese and shrimp and scallops. Fish and chicken contain very little cholesterol [10].

There are several types of cholesterol, namely High-Density-Lipoprotein (HDL) cholesterol and Low-Density-Lipoprotein (LDL) cholesterol. High levels of HDL cholesterol in the blood (about 40 mg/dl or more) are good for health. On the other hand, a high LDL level (100 mg/dl or more) is a bad sign. The buildup of LDL on the walls of blood vessels can cause hardening of the walls of blood vessels which can cause hardening of the walls of the arteries (atherosclerosis) and block blood flow which can be fatal because it triggers coronary heart disease and stroke. There are several factors that affect high cholesterol, including genetics, age, diet, stress, obesity, other diseases, drinking alcohol, and smoking [11][12]. There is plenty of evidence to suggest that the lower the cholesterol level, the better in reducing the risk of disease. Moreover, if accompanied by lifestyle changes, will further reduce the risk of heart attack or stroke. Although a direct correlation between high levels of LDL cholesterol and coronary heart disease and stroke has been proven.

2.2 Corn Hair

Corn is an annual crop. One life cycle is completed in 80-150 days. The first half of the cycle is the vegetative growth stage and the second half is the generative growth stage. High corn plants vary greatly. Although corn plants are generally between 1 m and 3 m in height, there are varieties that can reach 6 m in height. Plant height can be measured from the soil surface to the top segment before the male flowers.

Corn hair is a collection of fine, soft stigmas that look like threads or yellowish hairs [13] [14]. Corn silk comes from the female flowers of the corn plant. At first the color of corn hair is usually light green, then it will change to red, yellow, or light brown depending on the variety [15]. The function of corn silk is to trap pollen for pollination. Corn hair length can reach 30 cm or more and has a slightly sweet taste.

The benefits of corn silk are as traditional medicine, such as can be used for laxative urine and lowering cholesterol levels in the blood. Corn, especially the corn hair part, has medicinal benefits. This is because corn silk contains chemical compounds that are useful for health. One of the substances contained in corn silk is beta sitosterol. The beta sitosterol substance is thought to have an effect on lowering blood cholesterol levels.

The chemical content of corn silk includes protein; carbohydrate; fiber; some vitamins such as vitamin B, vitamin C, vitamin K; essential oil; mineral salts such as Na, Fe, Si, Zn, K, Ca, Mg and P [16]. Some of the phytochemical compounds contained in corn silk include alkaloids, saponins, tannins, flavonoids, anthocyanins, procatechins, vanilic acid; steroids such as stigmasterol, hasperidin derivatives, quercetin; and also beta-sitosterol which is one of the substances that can affect blood cholesterol levels. In addition, corn silk also contains maysin, -carotene, geraniol, hordenine, limonene, menthol, and viteskin [17].

3. EXPERIMENTAL

This research is a descriptive observational study with a case study approach on cholesterol based on the report of the World Health Organization (WHO) in 2002. This writing is supported from books, journals and optimization of 3D structures [18].

This research uses various websites which are the source of data search so that it can be analyzed. Following are some of the websites used:

1. <https://phytochem.nal.usda.gov/phytochem/search>
2. <https://pubchem.ncbi.nlm.nih.gov/>
3. <http://swisstargetprediction.ch/>

In this study also used computer applications, namely ChemDraw Ultra 12.0 and Chem3D Pro12.0. This application is used to visualize the active compounds found and can calculate the energy of compounds. This study was conducted according to the following procedure:

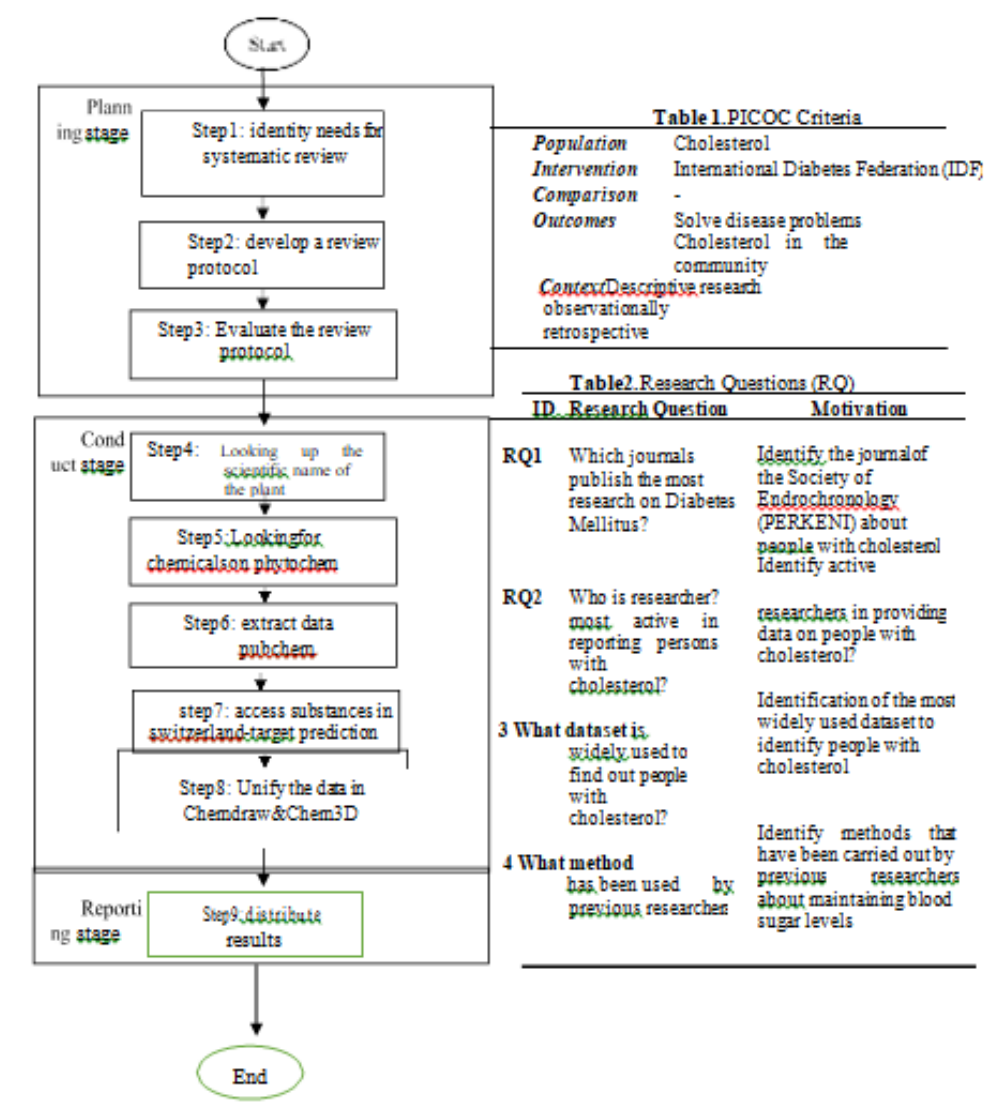


Figure 1. Procedure

4. RESULTS AND DISCUSSION

4.1 Results

After the type of active compound is known, the ability or target of the compound can be identified if it is tested on humans using Swiss Target Prediction. The following is data containing the data obtained along with the structure of the compound.

Beta

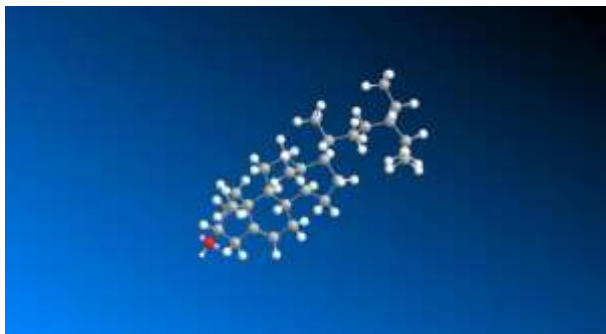


Figure 2. Beta- Sitosterol

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.....MM2 Dynamics.....
Warning: Some parameters are guessed (Quality = 1).
Iteration Time Total Energy Potential Energy Temperature
-----
5 0.010 475.566 ± 19.612 271.903 ± 58.552 833.24 ±272.80
10 0.020 394.111 ± 11.582 222.205 ± 29.871 703.32 ±115.56
15 0.030 682.561 ±126.621 375.297 ±141.269 1257.10 ±317.86
Dynamics terminated because the molecular model is too far from
equilibrium

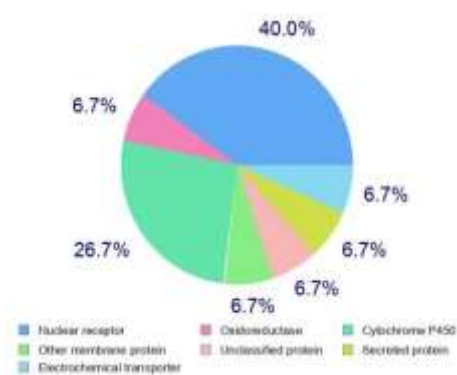
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-----MM2 Minimization-----
Warning: Some parameters are guessed (Quality = 1).
Minimization terminated normally because the gradient norm is less than the
minimum gradient norm
Stretch: 4.4282
Bend: 14.0025
Stretch-Bend: 0.8994
Torsion: 24.2775
Non-1,4 VDW: -7.7591
1,4 VDW: 23.9015
Dipole/Dipole:
0.3354 Total Energy:
60.0854 kcal/mol
Calculation completed

```

After optimization is done, it aims to produce Calculation completed,
with a total energy obtained of Total Energy: 60.0854 kcal/mol



Target	Common name	Uniprot ID	ChEMBL ID	Target Class	Probability*	Known actives (3D/2D)
Androgen Receptor	AR	P10275	CHEMBL1871	Nuclear receptor		28 / 102 ↓
HMG-CoA reductase	HMGCR	P04035	CHEMBL402	Oxidoreductase		36 / 7 ↓
Cytochrome P450 51 (by homology)	CYP51A1	Q16850	CHEMBL3849	Cytochrome P450		2 / 2 ↓
Niemann-Pick C1-like protein 1	NPC1L1	Q9UHC9	CHEMBL2027	Other membrane protein		11 / 13 ↓
LXR-alpha	NR1H3	Q13133	CHEMBL2808	Nuclear receptor		19 / 20 ↓
Cytochrome P450 19A1	CYP19A1	P11511	CHEMBL1978	Cytochrome P450		13 / 161 ↓
Cytochrome P450 17A1	CYP17A1	P05093	CHEMBL3522	Cytochrome P450		38 / 50 ↓
Nuclear receptor ROR-gamma	RORC	P51449	CHEMBL1741186	Nuclear receptor		10 / 9 ↓
Estrogen receptor alpha	ESR1	P03372	CHEMBL206	Nuclear receptor		9 / 39 ↓
Estrogen receptor beta	ESR2	Q92731	CHEMBL242	Nuclear receptor		8 / 47 ↓
Sterol regulatory element-binding protein 2	SREBF2	Q12772	CHEMBL1795166	Unclassified protein		1 / 1 ↓
Testis-specific androgen-binding protein	SHBG	P04278	CHEMBL3305	Secreted protein		1 / 48 ↓
Norepinephrine transporter	SLC6A2	P23975	CHEMBL222	Electrochemical transporter		3 / 2 ↓
Cytochrome P450 2C19	CYP2C19	P33261	CHEMBL3622	Cytochrome P450		0 / 3 ↓
Nuclear receptor ROR-alpha	RORA	P35398	CHEMBL5868	Nuclear receptor		3 / 3 ↓

Figure 3. abundant beta-sitosterol contained in the Nuclear receptor, in the form of Estrogen receptors

4.2 Discussion

Cholesterol is not a disease, but is a result of the body's metabolism of the fats we eat. Cholesterol is also made by the body itself (liver) because it is needed to form the brain, build cells, and produce bile, and produce hormones. The body requires a certain amount of cholesterol. Excess cholesterol will cause clots in the blood vessels. As a result, blood flow is disrupted, and if the disorder affects vital organs, such as the heart and brain. This is a health problem in today's society, especially those living in urban areas.

Corn silk contains chemical compounds that are useful for health [19], one of the substances contained in corn silk is beta sitosterol which is useful for reducing blood cholesterol levels. Corn silk has several properties, namely it can be used to lower cholesterol levels, lax urine, reduce high blood pressure, acute and chronic kidney infections [20].

Vitamin C or ascorbic acid has a molecular weight of 178 with the molecular formula $C_6H_8O_6$ [21] [22]. In the form of colorless crystals, the melting point is 190-192°C. It is soluble in water, slightly soluble in acetone or low molecular weight alcohol. Vitamin C is poorly soluble in chloroform, ether, and benzene. With metals to form salts. The nature of the acid is determined by the ionization of the enol group at the third C atom. At low pH, vitamin C is higher. Vitamin C is easily oxidized, especially if it is present in the catalyst of Fe, Cu, ascorbate oxidase enzyme, light, and high temperature. An aqueous solution of vitamin C at a pH of less than 7.5 is still stable in the absence of a catalyst as above. Oxidation of vitamin C will form dihydroascorbic acid [23] [24].

Flavonoids are polyphenolic compounds so that they are chemically phenolic compounds, which are slightly acidic and soluble in bases, and because they are polyhydroxy compounds (hydroxyl groups) they are also polar so they can dissolve in polar solvents such as methanol, ethanol, acetone, water, butanol, dimethyl sulfoxide, dimethyl formamide [25]. In addition, the presence of glycoside groups bound to flavonoid groups tends to cause flavonoids to be easily soluble in water. These compounds are red, purple, blue, and yellow colored substances found in plants [26].

Flavonoids affect carbohydrate metabolism in several ways [27]. First, flavonoids prevent the function of the amylase enzyme, an enzyme in saliva that starts the carbohydrate digestion process, because it can cause impaired absorption of glucose derived from complex carbohydrates into simple ones. Second, flavonoids prevent the action of sucrose and glucosidase enzymes that are important for the digestion of carbohydrates in the small intestine [28]. The end result is reduced carbohydrate absorption and lower blood glucose levels. This reason is convincing why corn silk is useful in the process of dissolving gallstones, namely by reducing carbohydrate levels in the body [29]. Given that carbohydrates are the main source of body fat, flavonoids reduce the amount of cholesterol that enter.

In the gallbladder, absorbs excess fat in gallstones and reduces the possibility of the formation of new stones and prevents the accumulation of cholesterol against other stones that have formed. A good corn hair drying process is carried out at a temperature of 30°C-90°C (best 60°C). However, on the condition that the active ingredients are not resistant to heat or contain volatile materials, it is carried out at a temperature of 30°C-45°C or carried out using a vacuum oven. Generally, colored compounds have a susceptibility to sunlight. In addition to having to pay attention to how the drying is carried out, the drying process must also pay attention to the thickness of the dried simplicia [30].

The mechanism of action of beta-sitosterol in lowering blood cholesterol is firstly, reducing the absorption of cholesterol including triglycerides and other dietary fats in the digestive system. The reduction in cholesterol absorption is done by locking or binding fat molecules from food and blocking these fat molecules from being absorbed by intestinal mucosal cells.

5. CONCLUSION

There is a decrease in blood cholesterol levels when using corn silk. Because corn silk contains a substance that can lower cholesterol levels in the blood, which is called beta-sitosterol. The mechanism of action of beta-sitosterol in lowering cholesterol in the blood is firstly, reducing the absorption of cholesterol including triglycerides and other dietary fats in the digestive system. Inhibition of absorption of cholesterol and triglycerides will cause chylomicron anabolism to be small which causes serum triglyceride levels to be small and intake of dietary cholesterol and triglycerides to the liver is also reduced. This will result in VLDL anabolism and low serum LDL cholesterol levels. The low VLDL anabolism causes low serum triglyceride levels. Cholesterol, triglycerides, and other dietary fats that are not absorbed by the intestinal mucosal cells due to the presence of beta-sitosterol will be excreted in the feces along with bile salts

Second, reduce the amount of cholesterol production in the liver. Beta-sitosterol that is absorbed by intestinal mucosal cells will be transported through lipoproteins. With the presence of beta sitosterol which is also absorbed and transported through lipoproteins, it can also reduce cholesterol biosynthesis in the liver. This results in a decrease in total cholesterol, triglycerides, and LDL cholesterol as well as an increase in HDL cholesterol

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